

Assignment 2 - Introduction to Industry 4.0 Essay (ACPA7004)

Introduction Industry 4.0

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MSc International Innovation Management

27/01/2023

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Introduction

The world is currently in its fourth industrial revolution (Industry 4.0), with the new technological developments affecting each country's society and economy.

At the end of the eighteenth century, the first industrial revolution (industrial revolution) replaced manpower and hand production with steam engines throughout Western Europe and North America.

A century later, the second industrial revolution (technological revolution) introduced mass production, standardisation, industrialisation and electrification to the world.

The third industrial revolution (digital revolution) which began in the latter half of the twentieth century, and somewhat continues today has been the shift from mechanical and analogue equipment, to digital electronics.

Industry 4.0 is described by Posada et al (2015) as a collective term for a wide number of technologies from value chain organisations, with industry 4.0 components being individually categorised as:

- The Internet of Things (IoT)
- Cyber Physical Systems
- Internet of Services and
- Smart Factories

With the adoption of new innovations and increased digitalisation, small medium enterprises (SMEs) can significantly improve competitiveness on the global market and create manufacturing efficiency gains.

Despite the significance of industry 4.0, it is well documented in literature the rate of implementation among SMEs in smaller and developing countries is generally low when comparing with larger, more industrialized nations (Rojas-Berrio et al, 2022) (Agostini & Nosella, 2019).

A number of studies on the low penetration of industry 4.0 technologies in smaller, developing nations have been published. Muller et al (2017) claim the reason for this is the lack of appropriate model to implement the newest technologies, which can be attributed to a lack of foundational knowledge on the subject matter. Raj et al (2019) agree with this study and state following their study, that a lack of digital strategy and resource scarcity are the greatest barriers in both developed and developing nations. A number of conflicting

proposals can be found in literature, this study will look at the main obstacles to the implementation of new technologies.

This essay has been written to investigate the impact of adopting industry 4.0 technologies by SMEs in smaller countries and what this undertaking entails.

Romania is currently the worst performing country of the EU nations. A deep dive has been performed into the current position of the country.

Adopting industry 4.0 technologies by SMEs in smaller countries

There are a number of classifications and perceptions of what 'smaller countries' relates to. A better term for this is 'emerging country'. To correctly determine these countries, the World Economic Forum (WEF, 2018), Readiness for the Future of Production Report 2018 has been used as a guide.

This report highlights that just twenty five (25) countries from Europe, North America and Asia are 'leading' countries, with 75% of global Manufacturing Value Added (MAV) taking place at these locations already. The leading countries can be seen below:

Austria, Belgium, Canada, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Israel, Italy, Japan, Republic of Korea, Malaysia, Netherlands, Poland, Singapore, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States.

The European Union defines an SME as an enterprise that has revenue of less than fifty million euros (€50M) and no more than 250 employees. In Europe, SMEs account for 67% of the jobs in the private sector, that figure rises to more than 80% when considering industrial companies.

Based on a review of relevant literature, barriers to the adoption of industry 4.0 technologies have been determined and will be considered for discussion.

High Investment in Industry 4.0 Implementation

According to Elhusseiny and Crispim (2022) a barrier to implementing industry 4.0 is the high investment costs. The study claims that this was only highlighted as a concern in developing countries. In a study conducted in Columbia, Rojas-Berrio et al (2022) also determined that access to financial resources and level of investment in new technologies is not comparable to leading countries. Similarly, Endrodi-Kovacs and Stukovszky (2022) found in a case study of Hungarian SME's, just 55% of Hungarian businesses have made small investments in digital technologies, significantly below the EU average.

Lack of Clarity Regarding Economic Benefit

In a survey completed by Shrouf et al (2014), it was observed that 82% of companies with smart manufacturing claimed there has been an increase in efficiency as 49% went through fewer product defects while 45% experienced an increase in customer satisfaction, proving that industry 4.0 technologies benefit organisation economically. Although, the high cost of investment and the long-time of the return of the investment are factors that stop firms from being convinced to implement the technologies.

Challenges in Value-Chain Integration

Technical, organizational, standardization, data management, and cybersecurity are all issues faced implementing industry 4.0 technologies to enhance value chain integration. Shamim et al (2017) claim that management support and dedication to accept the changes is crucial to success. Savtschenko et al (2017) go further, stating that organizations should focus on improving their capabilities in terms of employee training and development and security management programmes.

Risk of Security Breaches

With increased connectivity and networked links between value chain partners, comes the concern about security risks when sharing information among channel partners. When talking about cloud computing, Tascon et al (2022) claim security issues and availability outweigh the potential benefits to some SMEs. Moeuf et al (2020) also considered cyber security at SMEs in a production area, following a literature review, they concluded that security was not central to their works. In another study, Kondiloglu et al (2017) determined that a major breach to security were the people using industry 4.0 technologies. To make their point, they use the example of leaving a computer logged in, if the computer user can access contents without authority on the network, it will violate the security of information.

Low Maturity Level of Preferred Technology

Moeuf et al (2020), state that the speed of adoption of industry 4.0 technologies in developing nations carries the risk of obsolescence of an investment in technology. They go on to express that by the time the chosen technology would finally be implemented and mastered, another more efficient (or the same but improved) piece of technology may already be in use by competitors.

Inequality

Industry 4.0 may influence the labour market positively or negatively. In 1930, John Maynard Keynes, an English economist who's idea changed economic policies of governments predicted in an essay titled 'Economic Possibility for our Grandchildren', that by the year 2030, labour saving technologies may lead to a fifteen (15) hour working week (Jones, 2020). Although this is unlikely, a shift like this would further widen the gap between leading and developing countries.

Disruption to Existing Jobs

There are two opposing ideas when considering the impact of emerging technologies on the labour market. Firstly, those who believe that workers displaced by technology will find new jobs, allowing the technology to unleash a new era of prosperity. Secondly, those who believe it will lead to a progressive social and political upheaval by creating technological

unemployment on a massive scale (Schwab, 2017). According to a Future of Employment report, around 47 percent of total US employment are in the high risk category (Frey and Osborne, 2017). The choice to continue with traditional methods of production set countries back in their progress, keeping labour positions that will be obsolete in five to ten years.

Lack of Standards and Regulations

The lack of standards and regulations hinders both internal and external collaboration and industry 4.0 technology implementation. According to Friedman and Goldstein (2019), a lack of standards and standards architecture is likely slowing IoT adoption or discouraging manufacturers from developing new technological solutions. Türkeş et al () conducted a study in Romania that concluded a lack of standards is a crucial barrier to the introduction of industry 4.0 among 176 SMEs.

Lack of Digital Skills

Whether SMEs are the user or provide of technologies, personnel with industry 4.0 related skills will be required. Training of employees in these skills should be fundamental to a business's industry 4.0 implementation strategy (Han and Trimi, 2022). Similarly, Salimon et al (2019) examined factors that influence industry 4.0 implementation in both Malaysia and Nigeria and found that, among SMEs in Nigeria, there was a reluctance apply technologies as a consequence of the lack of internal skills, expertise and knowledge. Elhusseiny and Crispim (2022) found that not only developing countries suffer with a lack of knowledge within the workforce, but many leading countries share this obstacle.

Resistance to Change and Ineffective Change Management

The speed at which technology iterations occur has tremendously remodelled the way in which change happens.

There are many models available to follow when establishing change. One of the classic approaches to follow for a manager would Lewin's (1943) three (3) step model. Without following a model change is difficult to manage and can often become unfeasible, as employees will become unwilling to change the way that they work. Han & Trimi (2022) proposed some more recent strategies that could be implemented to overcome the challenges brought about by this technological change. The requirement to change internal processes to adopt the latest technologies successfully is also mentioned.

Lack of a Digital Strategy

Application of industry 4.0 is a strategic decision for an organisation. IW Consult (2015) claims that 40% of all SMEs do not have a digital strategy, whilst in larger organisations this figure is just 20%. Without the impetus and involvement of management the dissemination of

Industry 4.0 will be confined within narrow limits. An organisation's strategy should be mediated by investment in technology, which has to generate competitive advantages (Rojas-Berrio et al, 2022).

[Resource Scarcity](#)

Unlike their larger counterparts, SMEs often face major challenges with resource constraints. SMEs often do not have their own IT department, which means that the managers themselves have to assess the various Industry 4.0 technologies with regard to their technological maturity and business potential. These differences may also be the reason why small and medium sized enterprises frequently encounter difficulties in selecting the right solution and complain of a lack of user transparency (Schröder, 2017).

[Lack of Infrastructure](#)

Prause (2019) says that the most significant determinant to adoption is the relative advantage of the innovation compared to the competition and its compatibility with the existing infrastructure. In a paper by Moktadir et al (2018), they used the 'best worst method' (BWM) to try to determine the leading barriers to implementing industry 4.0. A lack of technological infrastructure came out in the top three (3).

[Case study of Industry 4.0 in Romania](#)

Each of the aspects above give clarity on how important industry 4.0 is to the development of a country. Digitisation is at the forefront of fetching developing nations in line with leading countries, and should not be neglected.

A plethora of new technologies are released to market annually, early adopters will have a significant advantage over competitors. Currently, some developing countries are significantly behind not only their neighbours, but the rest of the world.

Romania is a country in south-eastern Europe, situated on the shore of the Black Sea and is the largest of the Balkan countries.

Romania is a low performer amongst EU member states when it comes to digitalisation and implementation of industry 4.0 technologies. It ranks 27th out of the 27 EU member states in the 2021 and 2022 editions of the Digital Economy and Society Index (DESI, 2021).

Regarding the integration of digital technology in the activities of enterprises, Romania ranks 25th in the EU. When considering human capital, the country is well below the EU average, ranking 26th.

Most indicators considered are well below the EU average as seen in Figure 1 (DESI, 2022).

It is also important to note that Romania's relative growth is behind that of other EU member states.

Romania has some competitive strengths which could help develop the industry 4.0 in the country. The IT sector in Romania is very developed and the country has a highly skilled workforce in this sector especially its high rankings in the proportion of female ICT specialists in employment (ranking 2nd) and ICT graduates (ranking 4th).

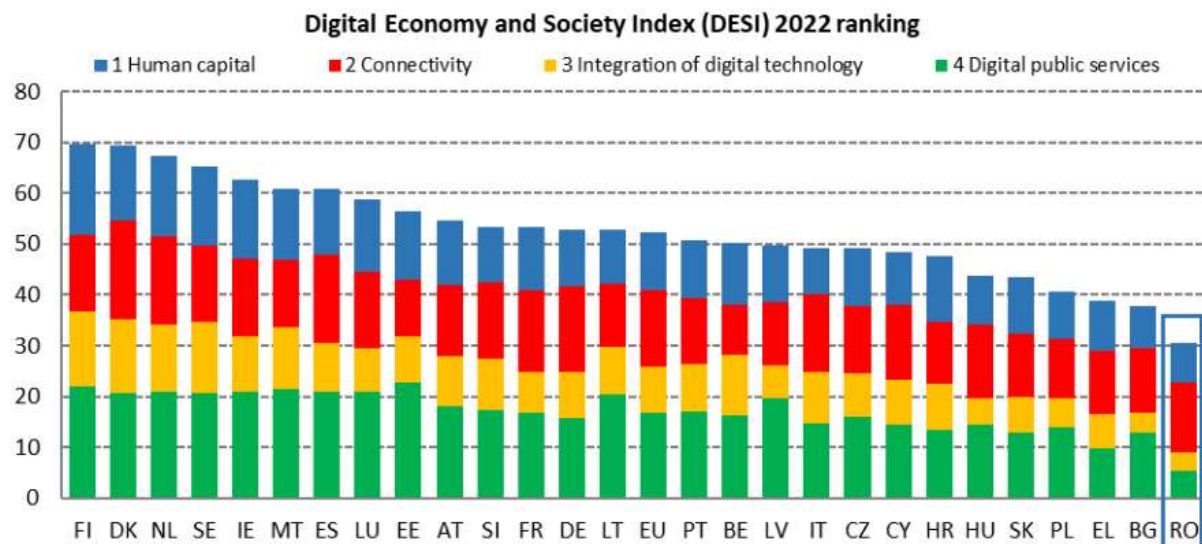


Figure 1 - DESI 2022 EU Nation rankings (DESI, 2022)

Digitisation

In Romania, policy makers must ensure that the correct questions are asked to enable the country to capitalise on the fourth industrial revolution. The importance of speeding up digitalisation is acknowledged by the national government, and promised to support this by creating a program to be implemented by a number of ministries, including the ministry of communications (Veith, 2018). The Romanian government have suggested a digital agenda rather than a strategy for exploiting industry 4.0 technologies, although, are also aware of the low level of development to date, along with the lack of infrastructure available to create a digitalised economy. Attributed to this, Romania has been ranked by the European Commission (2022) as emerging innovators, again, well below the EU average (Figure 2).

The report also highlights that the rate of performance increase (0.2%) is much slower than the EU average (9.9%), highlighting that the country's performance gap is increasing.

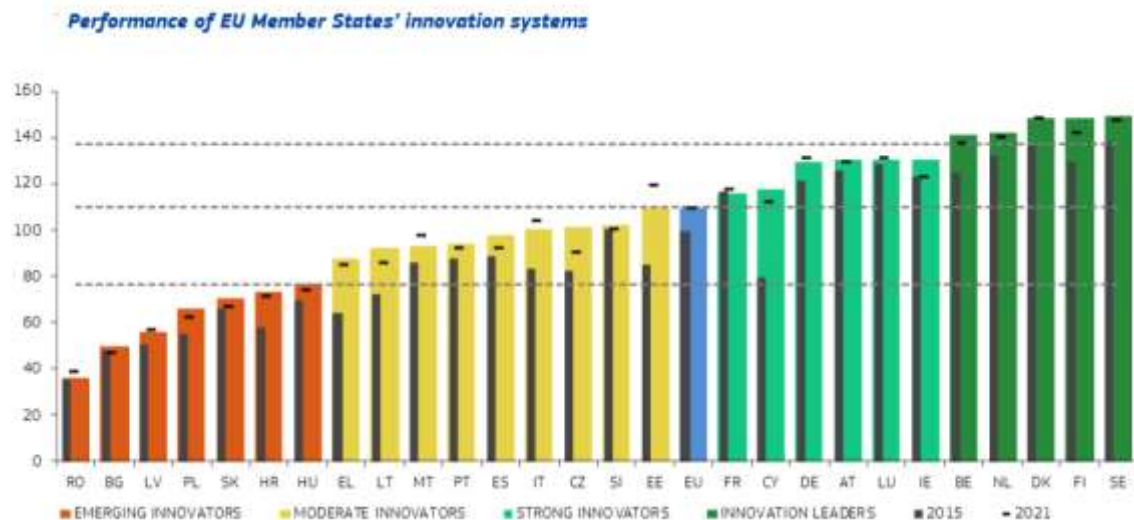


Figure 2 - European Innovation Scoreboard (2022)

An area in which Romania ranks better against its EU counterparts is connectivity, coming in tenth (10th) when considering coverage (87%) (DESI, 2021). The speed of the internet available is one of the fastest throughout Europe (Sosu, 2018). Romania also has excellent coverage of fifth generation (5G) mobile communications. 5G is seen as one of the essential ingredients for the economic transformation anticipated by the fourth industrial revolution. Ionescu et al (2021) goes further, claiming that 5G is significant progress in all activities (ie. social, various business sectors, IoT, and economic entities). Although, the benefits of this disruptive advancement of technology are not expected to materialize at a global level until 2035 according to National Regulatory Authority for Communications and Information Technology of Romania (ANCOM), (n.d).

The author has conducted a SWOT analysis of Romanian digitalisation (Figure 3).

<u>SWOT analysis of Romanian digitalisation</u>	
Strengths: - Strong ICT sector with a skilled workforce - Good internet connectivity/availability - Some competitive national and international organisations	Weaknesses: - Clarity required between education and market needs - Weak results when regarding digitisation (last in DESI) - Lack of real governmental support

Opportunities:	Threats:
- Worldwide developments in relation to digitalisation of industry -Existing and future EU cooperation schemes available -Emergence of new value chains	- Failure to adequately prepare people for the rapid transformation of the labour market - Delays in adapting to the digital economy - Absence of a national strategy for digitalisation

Figure 3 - SWOT analysis of Romania on digitalisation

Leading Organisations

The largest organisations within Romania, such as Deloitte, DHL, Volvo, Microsoft, Oracle and Honeywell all invest in transportation management system, warehouse management systems, mobile devices and applications that help track orders and supply chain transparency. However, it is SMEs that are leading the way for introducing industry 4.0 technologies to the country.

Transilvania Digital Innovation Hub through Transilvania IT Cluster have launched the Industry 4.0 working Group which supports the adoption of digital technologies and provides a platform for dialogue, encouraging collaboration across industry, aiding the innovation process and digitally transforming the country (Huf Group, 2022).

Another organisation looking to help other SMEs explore the advantages of industry 4.0 is the Huf group. This German automotive manufacturer realised the potential of Romanian talent base, such as software engineers and developers. Huf considers the location strategically important and claim to have contributed to the development of the country

Strategic policies for Industry 4.0

Strategic policies for industry 4.0 are well defined. The most common strategy is the gradual use of new digital technologies in existing companies, which corresponds best to the technological transition process. The majority of European countries, notably Germany, have used increasing productivity and greater efficiency as a focal point (Gheorghe, 2020). France meanwhile, have taken a market-based approach to companies taking part in their initiatives. The UK are focussing on being providers of technology and providing expertise on an industrial scale.

As previously mentioned, there is no strategy or initiative to address industry 4.0 coming from the government. Although, there are local and European programmes to address industry 4.0 in stages.

- The European strategy for Industry 4.0 in the period 2019-2023 and 2023-2027 and in the future
- Development of strategic industry programs and plans 4.0 (by industry / pilot enterprises), (eg Intelligent Production Program 2030, National University School of digitized Production, etc.)
- Integration of the industry strategy 4.0 nationally, developing technologies and infrastructures specific to industry 4.0

Barriers to adoption in Romania

Given the numerous barriers to industry 4.0, it is often difficult to predict which obstacles will be relevant to individual countries. For the case of Romania, from the literature reviewed by the author, the top three challenges for implementing industry 4.0 in SMEs are:

- Lack of knowledge – Specialized technical knowledge and skills can be acquired through vocational and academic training. Therefore, the Romanian government and universities need to develop programs, initiatives and curriculums to prepare society with the required competencies and skills.
- Capital investment requirements – Industry 4.0 technologies initially require large sums of capital investment. The Romanian governments should create detailed guidelines and appropriate legislation to fund programs, provide tax benefits along with other incentives for manufacturing organisations.
- Uncertainty of return on investment – Given that the industry 4.0 effort throughout Romania has mainly been made by the companies themselves, SMEs have up to now, shown little interest in investing in such a high-cost implementation, combined with a high risk of failure unless the firms have a clear picture of the economic benefit on investment and readily available work force with the right qualifications.

Romania's advantages

Eastern Europe is an attractive location for foreign investment. The markets are typically less developed than in Western Europe, with labour costs generally lower than leading European countries.

Over the last decade, the automotive industry has realised the potential in Romania and a number of global manufacturers have built factories there. Brands such as Ford, Volvo, Renault and Opel have become major pillars of Romanian manufacturing. All of these organisations will require SMEs to provide products and services, further developing the country.

As previously mentioned, connectivity in Romania is among the best in Europe. With great internet speeds, this creates the perfect environment for data flow, processing and data transfers.

Romania produces a significant number of IT graduates who are experts in IT security, big data, AI and much more. Paired with the good connectivity and fast internet speeds, it is fair to say that Romania has a well-developed IT sector.

Conclusion

The fourth industrial revolution is a logical step in the evolution of human kind, the latest of challenges to society. Civilization should have no fear about the use of robots in the industrialisation, there is no replacement for human intelligence, artificial intelligence (AI) will be by far more intelligent, than the intelligence of us humans, but AI will always depend on the latter, humans have the main role to play.

The latest technologies can slingshot all organisations into the competitive global market by becoming more productive, creating superior quality products more efficiently in a safer environment.

There are a large number of challenges for SMEs inhibiting the implementation of the latest technological advancements.

It takes a lot of work for a country to make itself appealing to foreign investment, and in the case of a country such as Romania, it takes a lot of effort to establish such stable values.

The disadvantages for implementation stem mainly from the lack of government initiatives available and the mentality of the population, rather than technological hurdles. Romania has many major future opportunities in the context of industry 4.0. To enable the nation to reach its full potential, a suitable digital strategy for transformation, needs to be created. This strategy should promote the adoption of IoT, AI, robotics and cloud computing. The future of industrial production is both digital and smart, Romania is as ready as it ever will be for industry 4.0 and Romania should not ignore it.

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